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THE SEMI-DISPATCHING SYSTEM AT THE LAC D'AMIANTE MINE: TRIP REPORT

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THE SEMI-DISPATCHING SYSTEM AT THE LAC D'AMIANTE MINE: TRIP REPORT

by

V. Srajer*.

ABSTRACT

The LAB Chrysotile Inc. company, Black Lake Operation's mine near Thetford Mines, Quebec, was visited in October 1988. The mine engineering staff in co-operation with Mine Engineering Department of McGill University in Montreal, developed and tested a site specific semi-automated dispatch system at the mine. The project was sponsored by the National Scientific and Engineering Research Council (NSERC) grant.

This visit report describes that semi-automated dispatching system.

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LE SYSTEME DE SEMI-REPARTITION A LA MINE LAC D'AMIANTE: RAPPORT DE VISITE

PAR

V. Srajer*

RESUME

La mine de Black Lake de la LAB Chrysoltile Inc. près de Thetford Mines au Québec a été visitée en octobre 1988. Le personnel technique de la mine en collaboration avec le département de génie minier de l'Université McGill à Montréal a mis au point et à l'essai un système semi-automatique de répartition propre à la mine. Le projet a été commandité par le Conseil de recherches en sciences naturelles et en génie (CRSNG).

Le présent rapport de visite décrit ce système semi-automatique de répartition.

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CONTENT

	Page
ABSTRACT	i
RESUME	iii
INTRODUCTION	1
MINING OPERATION	1
REVIEW OF DISPATCHING SYSTEM	2
CONCLUSION	5
ACKNOWLEDGEMENT	5
REFERENCES	8

LIST OF FIGURES

	Page
1. P&H-2100 Shovel Preparing Material for Loading	3
2. Cat 988 Loader Loading Ore	3
3. Old HP Microcomputer Used for Dispatching	6
4. New IBM PC System with Tablet	6
5. Detail of Tablet's Commands	7
6. New Screen Display	7

INTRODUCTION

The LAB Chrysotile's Black Lake mine is located on Highway 112, approximately 120 km south of Quebec City, west of town of Thetford Mines. Principal product of the open pit mine is chrysotile asbestos, a hydrous magnesium silicate whose chemical formula is $3MgO\ 2SiO_2\ 2H_2O$. The chrysotile asbestos from the mine is used in asbestos-cement applications, flooring and roofing felts, friction material for brake and clutch facings, and protective clothing.

The mine pit is approximately 6 km long, 2.2 km wide and will ultimately reach depth of 310 m. A total of 20 off-highway trucks are employed at the mine to move ore and waste material. Early in 1980's, a semi-automated dispatching system was developed in-house and tested at the mine. The system displayed location of the trucks in waiting queues to shovels. It was a passive system where all assignments were decided by the operators. During the last two years, mine engineering personnel and Mining Engineering Department of the McGill University in Montreal developed new upgraded version of the semi-automated dispatch system, now used at the mine. This version of the system is explained in this report.

MINING OPERATION

The asbestos ore mined by the Black Lake operations is located underneath a surface formerly covered by the lake. This lake, which originally had a surface of 244 hectares, is now reduced to 28 hectares.

The preliminary development of the mining section was by suction dredge, removing over 27.5 million m^3 of overburden (silt, sand, clay and boulder clay). Most of this material was moved up to 8 km from the original location. Since the start of the mining operation in 1954, the following tonnages have been moved by truck/shovel mining method:

Overburden.....52.4 Mt,
Waste rock.....185.6 Mt, and
Ore.....92.1 Mt.

A total of 3.3 Mt of asbestos have been produced since the opening of the mill in 1958. The ore reserves are sufficient to insure a current production for a period of up to 25 years.

Mining production is set at 48,000 tonnes of ore, waste rock and overburden daily. The 20-unit haulage fleet is made up of three 95 tonne, thirteen 85-tonne and four 46 tonne rear dump trucks.

The mine employs 425 hourly paid employees and 97 employees for supervision of operations and office work.

Figures 1 and 2 illustrate loading operations at the mine; P&H-2100 shovels and a Cat 988 wheel loader are used at the mine.

REVIEW OF DISPATCHING SYSTEM

The dispatching system operated at the mine has been entirely developed in-house by the mine operation superintendent, Mr. Aristide Leclerc. This system is semi-automated, the operator must supply the computer with information received from equipment operators by two-way radio. It displays the status and location of the equipment; all assignments are decided by the operators.

This dispatching system has been in operation since 1981, using an HP-9845C computer. The investment for this system was economically justified in less than a year by increased truck/shovel fleet productivity achieved through more efficient equipment utilization.

Since 1984 research has been conducted at McGill University in Montreal to elaborate dispatching policies/algorithms for dynamic truck assignment in open pit operations. This was done in the framework of a M.Sc. research project completed in 1987. The Black Lake Operation cooperated by supplying information about their dispatching system, fleet production and during time studies at the mine site. Stochastic simulation programs were written to test four fairly known dispatching policies based on heuristic rules. More advanced procedures were not throroughly studied since the mine's computer would preclude efficient implementation of elaborate procedures. The conclusion of the research was that even simple heuristic rules which require few computations can be applied to truck dispatching to improve fleet efficiency. However, it was realized that deductions drawn from the study had to be limited by the fact that the stochastic simulation programs developed did not include all the particularities of the normal mining operations. It was also realized that the simple dispatching procedures were limited in their capability to consider long term production objectives, such as grade, waste/ore ratios and quality constraints.

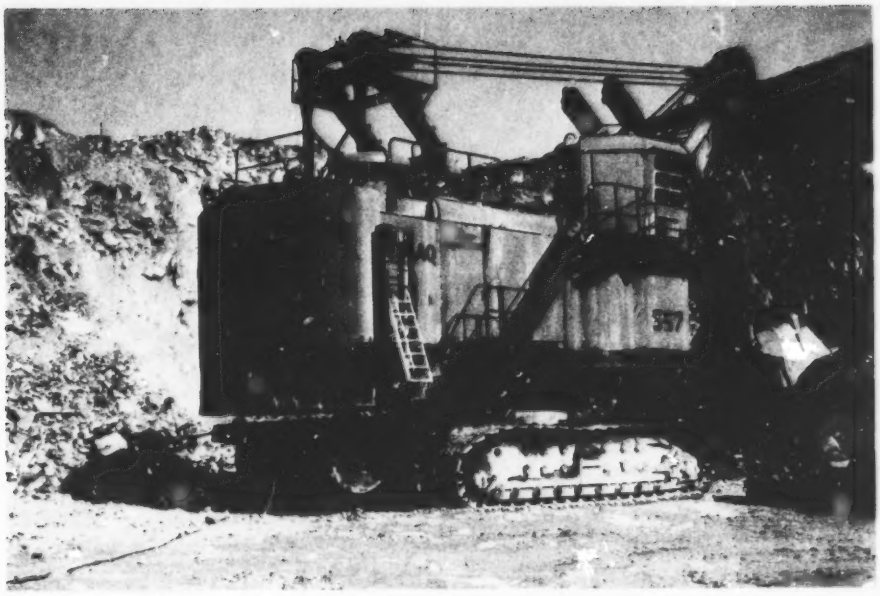

Fig. 1 P&H-2100 Shovel Preparing Material for Loading

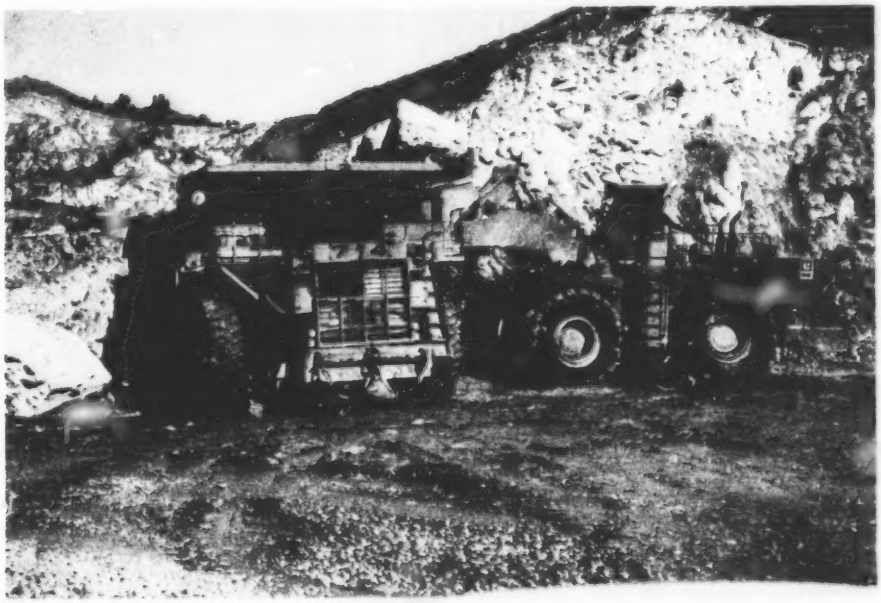

Fig. 2 Cat 988 Loader Loading Ore

A procedure, similar to the work done by researchers at Ecole Polytechnique in Montreal (1), was developed for the semi-automated Lac d'Amiante system (2). In this procedure the actual truck assignment is fairly straightforward in terms of solving a cost minimization in linear programming. The novelty of the procedure is the previous determination of the cost components, before operations start, while considering production planning constrains and/or objectives. The cooperative research project between the University and the mine has been subdivided into the following tasks:

1. Acquire new microcomputer

The IBM PC was selected for its high graphics resolution.

2. Additional time studies at the mine site

Two weeks were spend at the mine site to gather data by the University staff, one month was needed for additional surveys done by mine engineering personnel.

3. Compilation of production statistics

The detailed production statistics were obtained from the mine in order to validate the deterministic and stochastic simulation programs. Two months were allocated for this task.

4. Improving the deterministic simulator

The deterministic simulator developed at the University estimates travel time, assuming no other equipment interference. Later the program was improved to include initial truck assignments at the beginning of the shift. Later improvements generalized the program for unlimited road configurations and any additional equipment.

5. Generalization of the stochastic simulator

The simulator was upgraded to accommodate more elaborate dispatching procedures, account for more of the particularities of the mining operations such as breaks, equipment sizes, fleet changes during the shift, etc.

6. Reloading basic system on new microcomputer

Part of the code was machine dependent and therefore a systems analyst was needed to rewrite the program for new IBM cumputer.

7. Analysis of time study and testing of the simulator

An analysis of the time study data resulted in adjustment of the data calculated by the deterministic simulator.

8. Completion of dispatching procedure set

The 'maximize truck rule' was adjusted for different equipment capacities including the correction factor described in (3). The 'maximize shovel rule' was modified to account for different equipment capacities and consider equipment breakdowns. Mobile loading equipment was also partly considered. The 'match factor rule' was expanded by accessing the range of match factor values which can be used for each shovel using the stochastic simulation program and a linear programming module to determine the number of trucks which should work with each shovel to meet production planning objectives.

9. Generalization of the dispatching system

The system was generalized, making it applicable to most truck/shovel operations and ensuring that it can easily accommodate future modifications to the material handling system.

10. System testing

The program was tested at the mine site for the period of eight months. Several adjustments to the program were made.

Figures 3 to 6 illustrate the old and new computer systems developed at the mine site and sponsored in part by the NSERC grant.

CONCLUSION

The Lac d'Amiente mining operation at Black Lake, Quebec was visited in October 1988. The purpose of the visit was to monitor the progress of the semi-automated dispatch research program sponsored by NSERC grant.

The Lac d'Amiante mining operation clearly benefited by using the computerized dispatch system. The research accomplished at McGill University has shown them the possibilities of expanding their system. Although the desire to do so was present, the mining operation did not have the resources to undertake such an R&D project, a problem faced by many small operations. The NSERC grant help both organizations to carry such project and benefit from it.

ACKNOWLEDGEMENT

The author likes to thank Prof. Y. Lizotte of the McGill University, Department of Mining Engineering, and to Mr. A. Leclerc of the Lac d'Amiante Black Lake Operation for all information received during the visit of the University and mining operation.

Fig. 3 Old HP Microcomputer Used for Dispatching

Fig. 4 New IBM PC System with Tablet

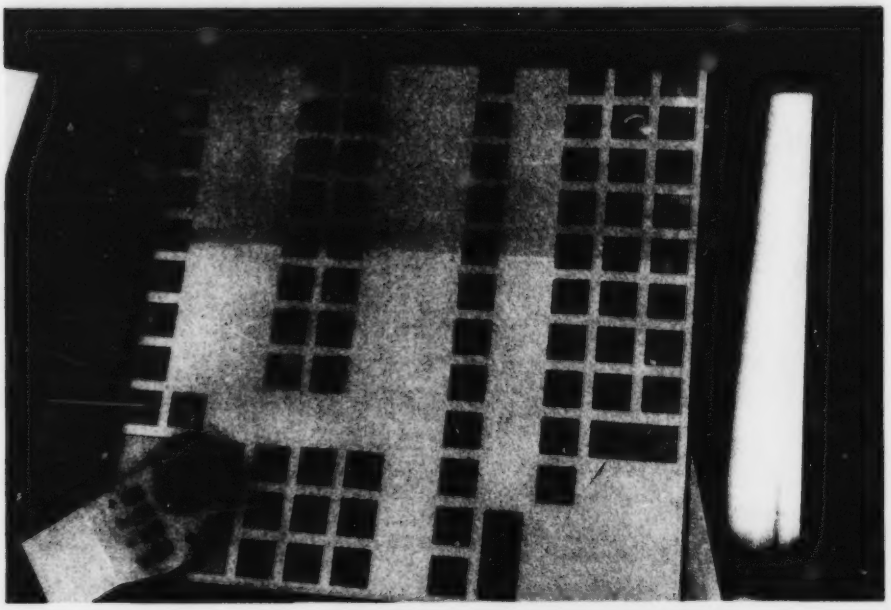

Fig. 5 Detail of Tablet's Commands

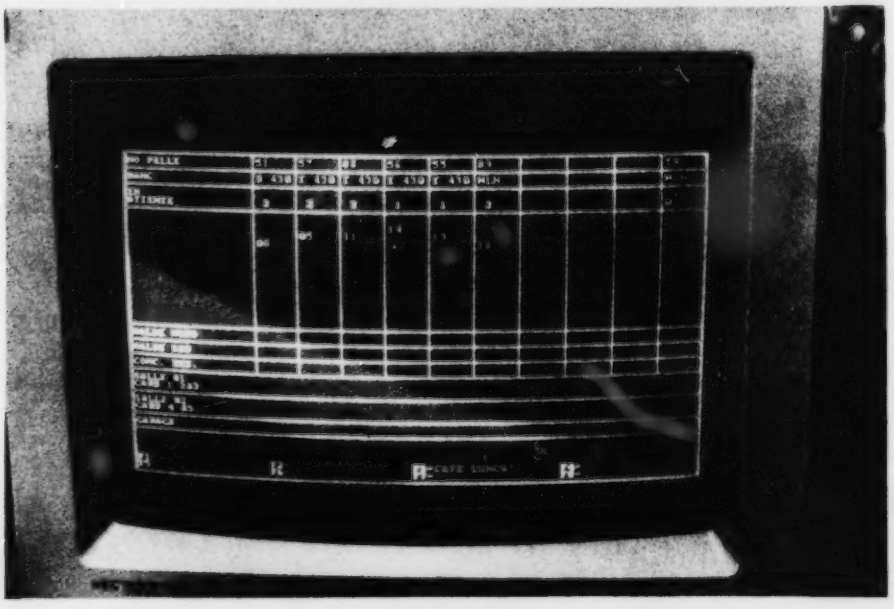

Fig. 6 New Screen Display

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